CLINICAL RESEARCH

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The influence of jaw innervation on the dental maturation pattern in the mandible

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Structured Abstract

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Objectives – To explore the relationship between mandibular dental maturation and the pattern of jaw innervation.

Setting and Sample Population – The sample included 365 panoramic radiographs taken in the period 1965–1969 in a Danish municipality.

Design – For assessing dental maturity, the seven left mandibular teeth (M2, M1, P2, P1, C, I2, I1) were given a dental maturity score according to a method introduced by Demirjian. Spearman correlation coefficients between the maturity score of an index tooth (one of each teeth) and the maturity score of the 6 other teeth was calculated and illustrated.

Results – All the correlation coefficients were larger than 0.5 indicating a rather high level of association between the development of mandibular teeth in the same individual. Thus, associations between the pattern of dental maturation and jaw innervation were not obvious.

Conclusion – When the correlation between the dental maturity stages was analysed, no significant relation was found between dental maturation and jaw innervation in the mandible. This is interesting considering the results presented in a recent study, which showed that the clinical observed tooth eruption was closely related to the pattern of jaw innervation. Those authors suggested that the factors influencing the eruption might be associated with jaw innervation. In our study, the stepwise dental maturation process, however, is not equally associated with jaw innervation.

Key words: dental maturation; correlation; tooth innervation; permanent teeth

Introduction

The formation of teeth is orderly, sequential, age-specific, and have been extensively studied. Although the developmental course of dentition is well known, the biological mechanisms behind dental maturation and eruption are not fully understood. Advances made in the fields of biochemistry and molecular biology, however, have increased our understanding of the mechanisms that regulate the processes.

It has been suggested that nerves in the vicinity of a developing tooth influence the surrounding tissues and initiate early tooth formation (1–3). A spatiotemporal distribution of nerve growth factor receptors (NGFR) during the early dental maturation process was also documented (4). Initially, the entire dental follicle is NGFR positive. At the onset of enamel secretion, however, the NGFR is only expressed in the apical area of the dental follicle. The disappearance of NGFR positive cells from the follicular tissue surrounding the crown at this very early stage of maturation implies that the nerve tissue does not specifically influence the maturational process of the teeth.

In a recent study, a higher correlation of emergence times was found between teeth within the same tooth group innervated by the same main nerve branch than between teeth from different tooth groups (5). The pattern of jaw innervation is assessed according to the prenatal course of the nerve tissue (6). Denervation studies have shown that removing of neurovascular structures of the teeth results in cessation of eruption (7). This supports the idea that eruption is influenced also by the jaw innervation. Furthermore, studies of dental maturity and tooth emergence have shown a close relationship (8).

Considering the close relation between jaw innervation and early tooth formation and also the strong correlation between jaw innervation and eruption the obvious purpose of our study was to elucidate the dental maturation pattern postnatally, from early tooth formation until complete root closure, and consider the influence of jaw innervation on dental maturation.

Materials and methods

Materials

The public Danish oral health care service for children includes screening for dental and occlusal abnormalities for all schoolchildren in the fourth grade. In the 1960s and 1970s radiographic screening with orthopantomographs was part of that procedure. Today radiographic screening is no longer performed. For this study 365 panoramic radiographs taken between 1965 and 1969 were collected from a Danish municipality. The sample included 190 girls and 175 boys. Their age ranged from 6.9 to 15.9 years for girls and 6.6 to 18.9 years for boys. Some of the children needed radiographic follow-ups, which explains why the maximum age exceeds the expected ideal age for an orthodontic screening; however, each child contributes with only one radiograph in this study.

Radiographic method

To assess dental maturity, the seven left mandibular teeth (M2, M1, P2, P1, C, I2, I1) were given a dental maturity score according to the method introduced by Demirjian and Levesque (9). The seven individual scores were summed up to give the total dental maturity score for the individual. The total dental maturity score indicates the dental age and in this study the total dental maturity scores ranged from 61.3 to 100% for the girls and from 62.9 to 100% for the boys.

Statistical methods

Spearman correlation coefficients with their 95% confidence intervals (CI) were calculated to assess correlation (10).

Results

The distribution of developmental stages registered in the sample is less for early developing teeth (M1, I1, and I2) than for later developing teeth (C, P1, P2, and M2), (Table 1). This reflects the age of the children when the radiographs were taken. All the correlation coefficients are larger than 0.5 (Table 2) indicating a rather high level of association between development of teeth in the same individual, both in girls and boys. Figure 1 describes the correlation between an index tooth and the six other teeth in the left side of the mandible. The vertical bars indicate the 95% CI. When contemplating the figure no obvious difference can be

Table 1. **Number and distribution of teeth according to developmental stage (9)**

		Stage								
Gender	Tooth	A	B	C	D	E	F	G	H	Total
Girls	M2			2	64	42	53	28	1	190
	M1						2	95	93	190
	P2			1	27	64	60	25	11	188
	P1				9	65	64	36	16	190
	C					23	89	50	28	190
	I2						14	61	115	190
	I1						1	41	148	190
	Total			3	100	194	283	336	412	1328
Boys	M2			2	57	47	48	15	5	174
	M1							100	75	175
	P2			1	35	51	72	8	8	175
	P1				12	59	69	23	12	175
	C				2	39	95	29	10	175
	I2						31	44	98	173
	I1						3	44	127	174
	Total			3	106	196	318	263	335	1221

$n = 190$ for girls; $n = 175$ for boys.

seen between maturity of teeth belonging to different tooth groups.

Discussion

In the present investigation the total dental maturity course from the first radiographic sign of tooth formation until complete root formation was examined. During this period of maturation the tooth erupts. From a panoramic radiograph, however, it is not possible to determine whether a tooth is in the pre-eruptive or in the eruptive phase. Consequently, only stages of dental maturity and not the stage of tooth emergence have been examined in this study.

When the correlation between the dental maturity stages was analysed, no significant relation was found between dental maturation and jaw innervation in the mandible. This is interesting within the framework of the results by Parner et al. (5) who suggested that the clinically observed tooth eruption was closely related to the pattern of jaw innervation. The stepwise dental maturation process, on the other hand, is not equally associated with jaw innervation. In another study the expression of NGFR in relation to the developing tooth bud was investigated. Interestingly, in the bell stage of the dental maturation process the NGFR reactions are not seen in the region of matrix producing ameloblasts but only in the apical aspects of the dental follicle (4). Enamel formation takes place in NGFR negative regions. As formation of enamel is a dental maturation process, it is obvious that the maturation process is dependent of innervation when compared to eruption less. As the eruptive force is supposedly generated in the NGFR-rich region of the apical dental follicle, it might explain the coexistence of jaw innervation on dental eruption.

Radiographic analyses, however, are not sufficient to infer a final conclusion on the biological mechanisms of dental maturation, and of eruption. Such

Table 2. **Spearman rank correlation coefficients ×100 (95% CI) for dental maturity score for the teeth in the left side of the mandible**

	M2	M1	P2	P1	C	I2	I1
M2		80 (71–89)	85 (77–93)	85 (77–93)	82 (73–90)	74 (64–84)	59 (48–71)
M1	69 (58–79)		71 (61–81)	73 (63–83)	71 (61–82)	69 (58–79)	54 (41–66)
P2	79 (70–88)	70 (60–81)		89 (82–96)	79 (70–88)	69 (59–80)	56 (44–68)
P1	83 (75–91)	69 (58–79)	84 (76–92)		81 (72–89)	74 (64–83)	61 (49–72)
C	72 (61–82)	63 (51–74)	71 (60–81)	80 (72–89)		68 (57–79)	51 (38–63)
I2	80 (72–89)	70 (60–80)	75 (65–84)	81 (72–89)	66 (56–77)		68 (57–78)
I1	68 (58–79)	50 (38–63)	56 (44–68)	65 (54–76)	50 (38–63)	78 (69–87)	

Coefficients for girls above the diagonal and coefficients for boys below the diagonal. All the correlation coefficients are larger than 0.5 indicating a rather high level of association between development of teeth in the same individual for both girls and boys. However, no obvious difference could be shown between maturity of teeth belonging to tooth groups innervated differently.

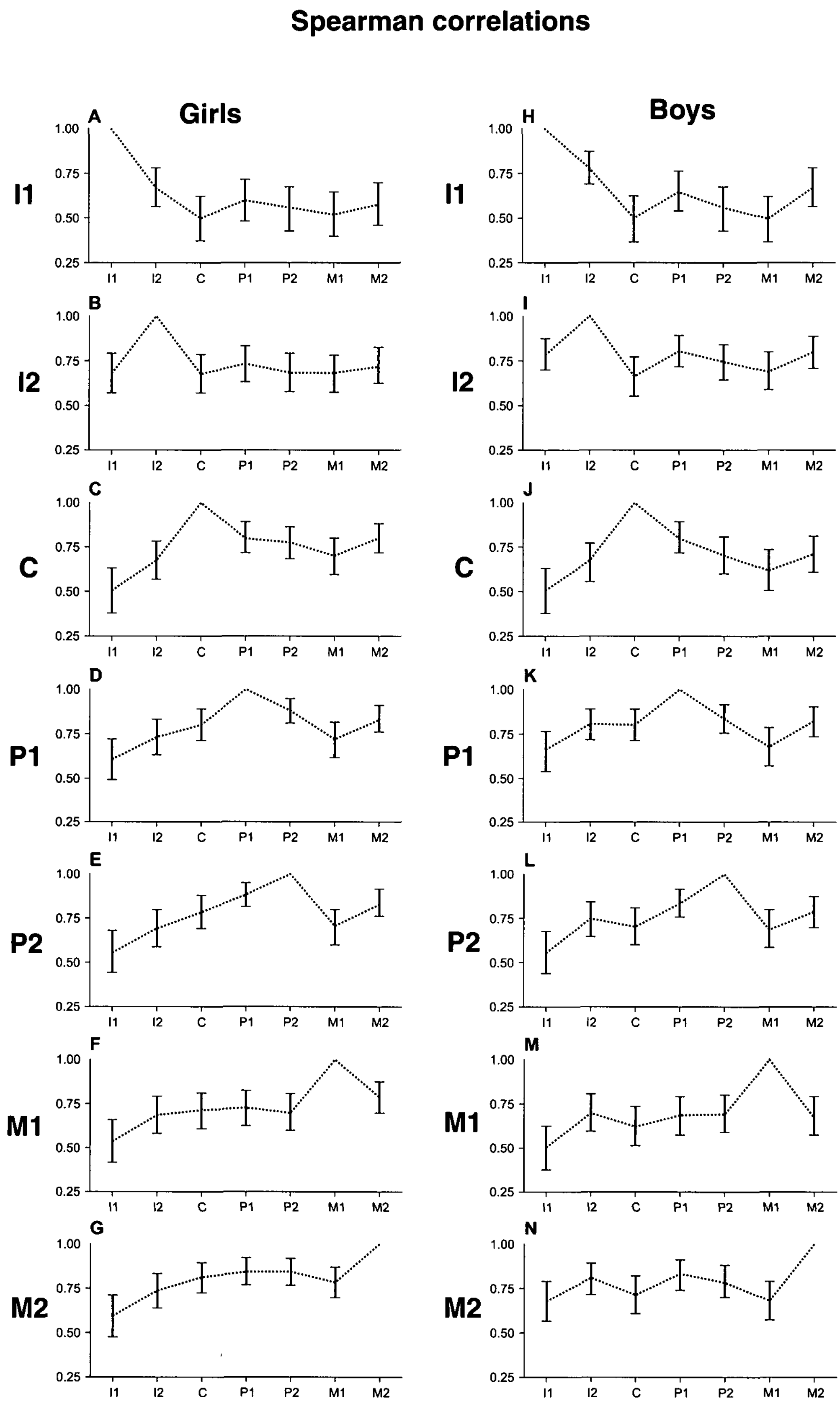

Fig. 1. Correlation between an index tooth and the six other teeth in the left side of the mandible. The vertical bars indicate the 95% CI. All the correlation coefficients are larger than 0.5 indicating a rather high level of association between development of teeth in the same individual for both girls and boys. However, no obvious difference could be shown between maturity of teeth belonging to tooth groups innervated differently.

understanding can only come from molecular biological studies. Such studies should focus on the follicular and periodontal tissues (11). Nonetheless, in this study we show that the maturational process must be considered separately from the eruptive. As eruption is most frequently initiated at a certain stage of maturation, the biological processes responsible for dental maturation and the biological processes responsible for dental eruption are often mixed in the literature. The present study shows that these biological processes should be considered separately as they are seemingly controlled by different factors. In this context, it is worth mentioning that the dental and the skeletal maturation processes appear unrelated and are controlled by different factors (12,13).

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